

FR-S 500

Frequency Inverter

Installation Manual

FR-S 520 S
FR-S 540 EC/ECR

About this Manual

The texts, illustrations, diagrams, and examples contained in this manual are only intended as aids to help explain the installation, set-up, and starting of the frequency inverters FR-S 520S EC/ECR and FR-S 540 EC/ECR.

If you have any questions concerning the programming and operation of the equipment described in this manual, please contact your relevant sales office or department (refer to back of cover).

Current information and answers to frequently asked questions are also available through the Internet (www.mitsubishi-automation.com).

MITSUBISHI ELECTRIC EUROPE B.V. reserves the right to make changes both to this manual and to the specifications and design of the hardware at any time without prior notice.

Installation Manual FR-S 520S EC/ECR und FR-S 540 EC/ECR Art. No:129918			
Version			Changes / Additions / Corrections
A	07/01	pdp	First issue
B	04/02	pdp	New rated currents for FR-S 540 EC/ECR
C	02/04	pdp – gb	General: Introduction of the overload capacity

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Safety Instructions

For qualified staff only

This manual is only intended for use by properly trained and qualified electrical technicians who are fully acquainted with automation technology safety standards. All work with the hardware described, including system design, installation, setup, maintenance, service and testing, may only be performed by trained electrical technicians with approved qualifications who are fully acquainted with the applicable automation technology safety standards and regulations. Any operations or modifications of the hardware and/or software of our products not specifically described in this manual may only be performed by authorised Mitsubishi staff.

Proper use of equipment

The devices of the FR-S series are only intended for the specific applications explicitly described in this manual. Please take care to observe all the installation and operating parameters specified in the manual. The design, manufacturing, testing and documentation of these products have all been carried out in strict accordance with the relevant safety standards. Under normal circumstances the products described here do not constitute a potential source of injury to persons or property provided that you precisely observe the instructions and safety information provided for proper system design, installation and operation. However, unqualified modification of the hardware or software or failure to observe the warnings on the product and in this manual can result in serious personal injury and/or damage to property. Only accessories specifically approved by MITSUBISHI ELECTRIC may be used with the frequency inverters FR-S 520S EC/ECR und FR-S 540 EC/ECR. Any other use or application of the products is deemed to be improper.

Relevant safety regulations

All safety and accident prevention regulations relevant to your specific application must be observed in the system design, installation, setup, maintenance, servicing and testing of these products.

The regulations listed below are particularly important. This list does not claim to be complete; however, you are responsible for knowing and applying the regulations applicable to you.

- VDE/EN Standards
 - VDE 0100
(Regulations for electrical installations with rated voltages up to 1,000V)
 - VDE 0105
(Operation of electrical installations)
 - VDE 0113
(Electrical systems with electronic equipment)
 - EN 50178
(Configuration of electrical systems and electrical equipment)
- Fire prevention regulations
- Accident prevention regulations
 - VBG No. 4 (electrical systems and equipment)

General safety information and precautions

The following safety precautions are intended as a general guideline for using the frequency inverter together with other equipment. These precautions must always be observed in the design, installation and operation of all control systems.



DANGER:

- *Observe all safety and accident prevention regulations applicable to your specific application. Installation, wiring and opening of the assemblies, components and devices may only be performed with all power supplies disconnected.*
- *Assemblies, components and devices must always be installed in a shockproof housing fitted with a proper cover and protective equipment.*
- *Devices with a permanent connection to the mains power supply must be integrated in the building installations with an all-pole disconnection switch and a suitable fuse.*
- *Check power cables and lines connected to the equipment regularly for breaks and insulation damage. If cable damage is found, immediately disconnect the equipment and the cables from the power supply and replace the defective cabling.*
- *Before using the equipment for the first time check that the power supply rating matches that of the local mains power.*
- *Residual current protective devices pursuant to DIN VDE Standard 0641 Parts 1–3 are not adequate on their own as protection against indirect contact for installations with frequency inverter systems. Additional and/or other protection facilities are essential for such installations.*
- *EMERGENCY OFF facilities pursuant to VDE 0113 must remain fully operative at all times and in all control system operating modes. The EMERGENCY OFF facility reset function must be designed so that it cannot cause an uncontrolled or undefined restart.*
- *You must also implement hardware and software safety precautions to prevent the possibility of undefined control system states caused by signal line cable or core breaks.*



CAUTION:

All relevant electrical and physical specifications must be strictly observed and maintained for all the frequency inverters in the installation. The load used should be a three-phase induction motor only. Connection of any other electrical equipment to the inverter output may damage the equipment.

Safety warnings

In this manual special warnings that are important for the proper and safe use of the products are clearly identified as follows:



DANGER:

Personnel health and injury warnings. Failure to observe the precautions described here can result in serious health and injury hazards.



CAUTION:

Equipment and property damage warnings. Failure to observe the precautions described here can result in serious damage to the equipment or other property.

1 Introduction

This Installation Manual includes a brief summary of the main specifications of the FR-S 500 frequency inverters, which should be sufficient to enable experienced users to install and configure the inverter. For further information on the functions and parametrization please refer to the Instruction Manual of the frequency inverter FR-S 500. This Installation Manual is intended exclusively as an installation and setup guide and a brief reference. It does not replace the main product manual.

1.1 General Description

The frequency inverters are available with outputs from 0.2 to 1.5kW for operation with single-phase 200 to 240V AC power supply (FR-S 520S EC/ECR) or 0.4 to 3.7kW with three-phase 380 to 480V AC power supply (FR-S 540 EC/ECR). The frequency range is from 0.5 to 120Hz.

Features of the frequency inverters

- Communication ability and networking
In the FR-S 500 ECR the comprehensive functions of the EC series are complemented by a serial interface (RS485) installed as standard equipment. This enables communication both with a personal computer and with a PLC, which can be networked with up to 31 other devices with RS485 interface.
- Compatibility with a lot of new applications
 - PID Control
The inverter can be used to exercise process control, e.g. flow rate for pumps
 - Stop function selection (terminal MRS)
This function is used to select the stopping method (deceleration to a stop or coasting).
- Large number of protective functions for safe operation
 - Automatic restart after instantaneous power failure
The inverter can be started without stopping the motor (with the motor coasting).
 - Built-in overcurrent protection
 - Retry function after alarm occurrence
- Compatible with numerous I/Os
 - Multi-speed setting
15 different pre-selected speeds are available
 - Control input for 0/4–20mA (0–10V)
 - 4 Multi-input terminals
Selection of different input variations from 14 different input types (e.g. digital motor potentiometer)
 - Multi-output terminals (1 Relais, 1 Transistor with open collector)
Selection of 2 different output variations from 12 different output types
 - 24V power supply output (24V DC/0.1A) for external devices
- Automatic torque boost

2 Specifications

2.1 Model Specifications

Type		FR-S 520S EC/ECR				FR-S 540 EC/ECR				
		0.2k	0.4k	0.75k	1.5k	0.4k	0.75k	1.5k	2.2k	3.7k
Rated motor capacity [kW] ^① 200 % Overload capacity		0.2	0.4	0.75	1.5	0.4	0.75	1.5	2.2	3.7
Output	Rated output capacity [kVA]	0.5	1.0	1.6	2.8	0.9	1.6	2.7	3.7	5.9
	Rated current [A]* 200% Overload capacity	1.4	2.5	4.1	7.0	1.2 (1.3)	2.3 (2.5)	3.7 (4.1)	5.3 (5.8)	7.7 (8.5)
	Overload capacity ^②	200% of rated motor capacity for 0.5s; 150% for 1min. (max. ambiente temperature 50°C)								
	Voltage ^③	3-phase, 0V up to power supply voltage								
Input	Power supply voltage	single-phase, 200–240V AC				3-phase, 380–480V AC				
	Voltage range	170–264V AC at 50 / 60Hz				325–528V AC at 50 / 60Hz				
	Frequency range	50 / 60Hz ± 5%				50 / 60Hz ± 5%				
	Rated input capacity [kVA] ^④	0.9	1.5	2.5	4.4	1.5	2.5	4.5	5.5	9.5
Protective structure		IP 20								
Cooling		Self-cooling			Fan cooling	Self-cooling		Fan cooling		
Weight [kg]		0.6	0.8	1.0	1.5	1.5	1.5	1.5	1.6	1.7
Control specifications	Control method		V/f control							
	Modulation control		Sinusoidal PWM, Soft PWM							
	Switching frequency		0.7–14.5kHz, user adjustable							
	Frequency characteristics		0.5–120Hz							
	Frequency resolution	analog	From terminals 2-5: 1/500 of maximum set frequency (input 5V DC); 1/1000 (input 10V, 20mA DC)							
	Frequency precision		±1% of max. output frequency (temperature range 25°C ± 10°C) during analog input; ±0.5% of max. output frequency during digital input (set via Digital Dial)							
	Possible starting torque		≥ 150% / 6Hz (with automatic torque boost))							
	Acceleration / deceleration time		0; 0.1 to 999s (may be set individually for acceleration and deceleration)							
	Acceleration / deceleration characteristics		Linear or S-pattern acceleration/deceleration mode selectable							
	Braking torque ^⑤	Regenerative	0.2k: 150%; 0.4k and 0.75k: 100%; 1.5k: 50%, 2.2k and 3.7k: 20%							
		DC-braking	Braking time and braking moment adjustable, Operating frequency: 0–120Hz, operating time: 0–10s, voltage: 0–15% (externally adjustable)							

* The values in brackets indicate the values for an ambient temperature up to 40°C without restriction of PWM.

Please observe the notes on page 10!

Type				FR-S 520S EC/ECR				FR-S 540 EC/ECR					
				0.2k	0.4k	0.75k	1.5k	0.4k	0.75k	1.5k	2.2k	3.7k	
Control signals for operation	Input signals	Frequency setting signal	Analog input	0–5V DC, 0–10V DC, 0/4–20mA									
			Digital	Control panel									
		Starting signal	STF, STR	Individual selection of forward / reverse run Start signal self retaining input. ⑪									
		Error reset	The error indication (alarm signal)is reset with the reset of the protective function ⑪										
		Multi-speed selection	Up to 15 speeds can be preset in the range of 0–120Hz. The current speed can be adjusted during operation via the control panel. ⑪										
		2nd function	Selects 2nd function (acceleration time, deceleration time, torque boost, base frequency, electronic overcurrent protection) ⑪										
		Output stop	Instant cutoff of inverter output (frequency and voltage) ⑪										
		Selection of current input	Frequency setting via current input signal 0/4 to 20mA DC (Terminal 4) ⑪										
		External thermal input	Stopping the inverter with an externally mounted thermal relay ⑪										
		JOG operation	Select Jog operation ⑪										
		PID control	Select PID control ⑪										
		PU <-> External operation	Switch between the operating modes “PU” and “External” ⑪										
	Operation functions			Maximum and minimum frequency setting, frequency jump operation, external thermal input selection, instantaneous power failure restart operation, forward run/reverse run prevention, slip compensation, operation mode selection, PID-control, Computer link operation (RS485) ⑥									
	Output signals	Operation status ⑫		1 output type (open collector output) selectable: Inverter running, frequency reached, frequency detection, overload warning, zero return detection, output current detection, minimum PID, maximum PID, PID forward run, PID reverse run, operation ready, minor failure and error, 1 relay contact can be selected for the output (230V AC; 0.3A / 30V DC; 0.3A)									
		Analog signal		One of the following output types can be selected: Output frequency, motor current, analog output (0–5V DC with 1mA full scale).									
Protection functions				Overcurrent (during acceleration, deceleration, constant speed), overload cutoff in internal converter (during acceleration, deceleration, constant speed), Overload (motor/inverter), fin overheating, fan error ⑦, Overcurrent cutoff, ground fault during start ⑧, external motor protection signal ⑨, PU connection error ⑥, no. of retries; communications error ⑥, CPU error, undervoltage ⑩									
Environment	Ambient temperature			–10°C to +50°C (non freezing)									
	Storage temperature			–20°C to +65°C									
	Ambient humidity			Max. 90% RH (non-condensing)									
	Ambience condition			For indoor use only, avoid environments containing corrosive gases, no oil mist, install in a dust-free location									
	Altitude			Max. 1000m above n.N.									
	Vibration resistance			Max. 0.6G									

Please observe the notes on page 10!

NOTES

| Special notes referring to the table:

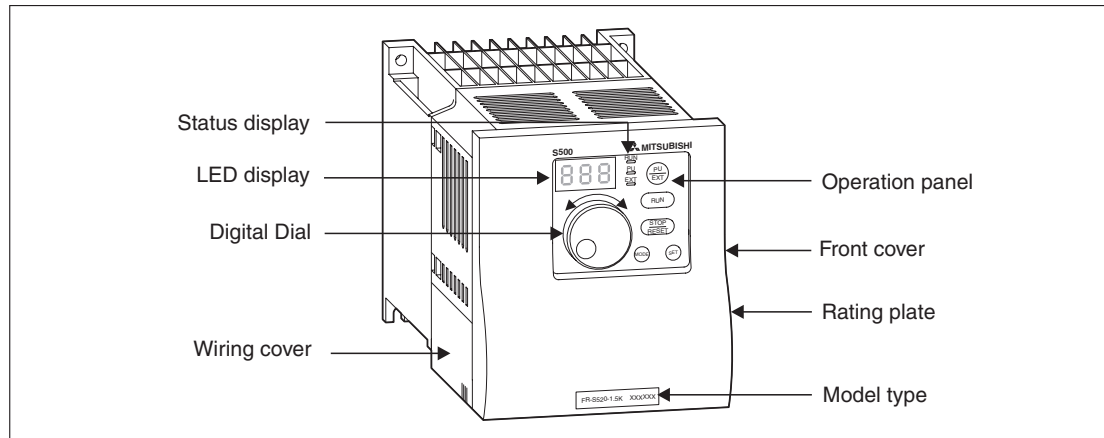
- ① The applicable motor capacity refers to a motor voltage of 230V (FR-S 520S) resp. 440V (FR-S 540).
- ② The overload capacity indicated in % is the ratio of the overload current to the inverter's rated current. For repeated duty, allow time for the inverter and motor to return to or below the temperatures under 100% load.
- ③ The maximum output voltage cannot exceed the power supply voltage. The maximum output voltage may be set as desired below the power supply voltage.
- ④ The power supply capacity changes with the values of the power supply side inverter impedances (including those of the input reactor and cables).
- ⑤ The braking torque indicated is short-duration average torque (which varies with motor loss) when the motor alone is decelerated from 50Hz in the shortest time and is not a continuous regenerative torque.
When the motor is decelerated from the frequency higher than the base frequency, the average deceleration torque will reduce. Since the inverter does not contain a brake resistor, use the optional brake resistor when regenerative energy is large. A brake unit BU may also be used.
- ⑥ Only valid for frequency inverters equipped with an RS485 interface.
- ⑦ Only valid for frequency inverters equipped with a cooling fan.
- ⑧ To activate the function, set parameter 40 to "1".
- ⑨ The input OH is activated by the parameters on the function assignment of the input terminals (Pr. 60 to Pr. 63).
- ⑩ When undervoltage or instantaneous power failure has occurred, alarm display or alarm output is not provided but the inverter itself is protected. Overcurrent, regenerative overvoltage, or other protection may be activated at power restoration according to the operating condition.
- ⑪ The input terminal function selection is made with parameters 60–63.
- ⑫ The output terminal function selection is made with parameters 64–65.

3 Appearance and Structure

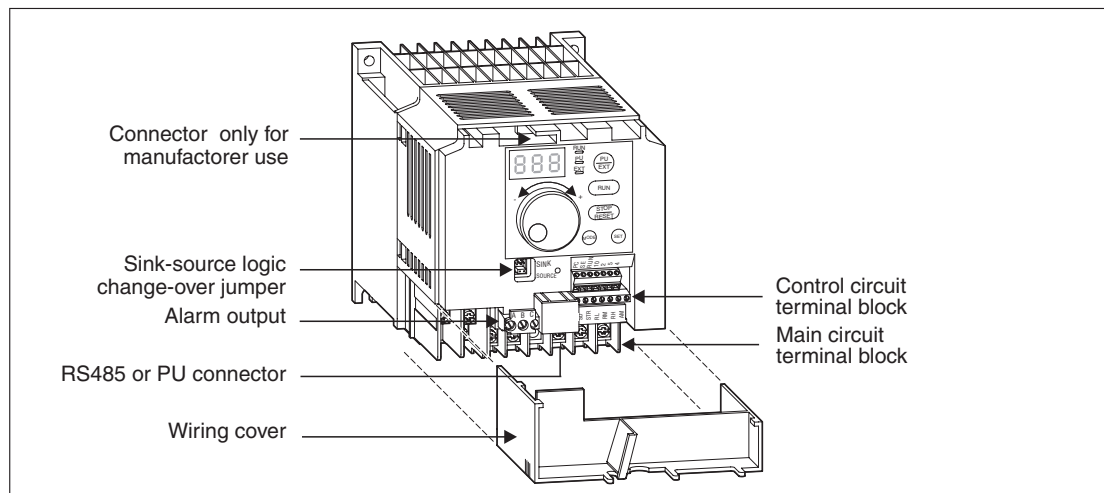
3.1 Description of the Case

Depending on the capacity class the frequency inverter is delivered in second different structural shapes of the case. The following drawings show a structured view of the single case components.

Frequency inverter FR-S 500 EC/ECR with front cover



Frequency inverter FR-S 500 EC/ECR without front cover



CAUTION:

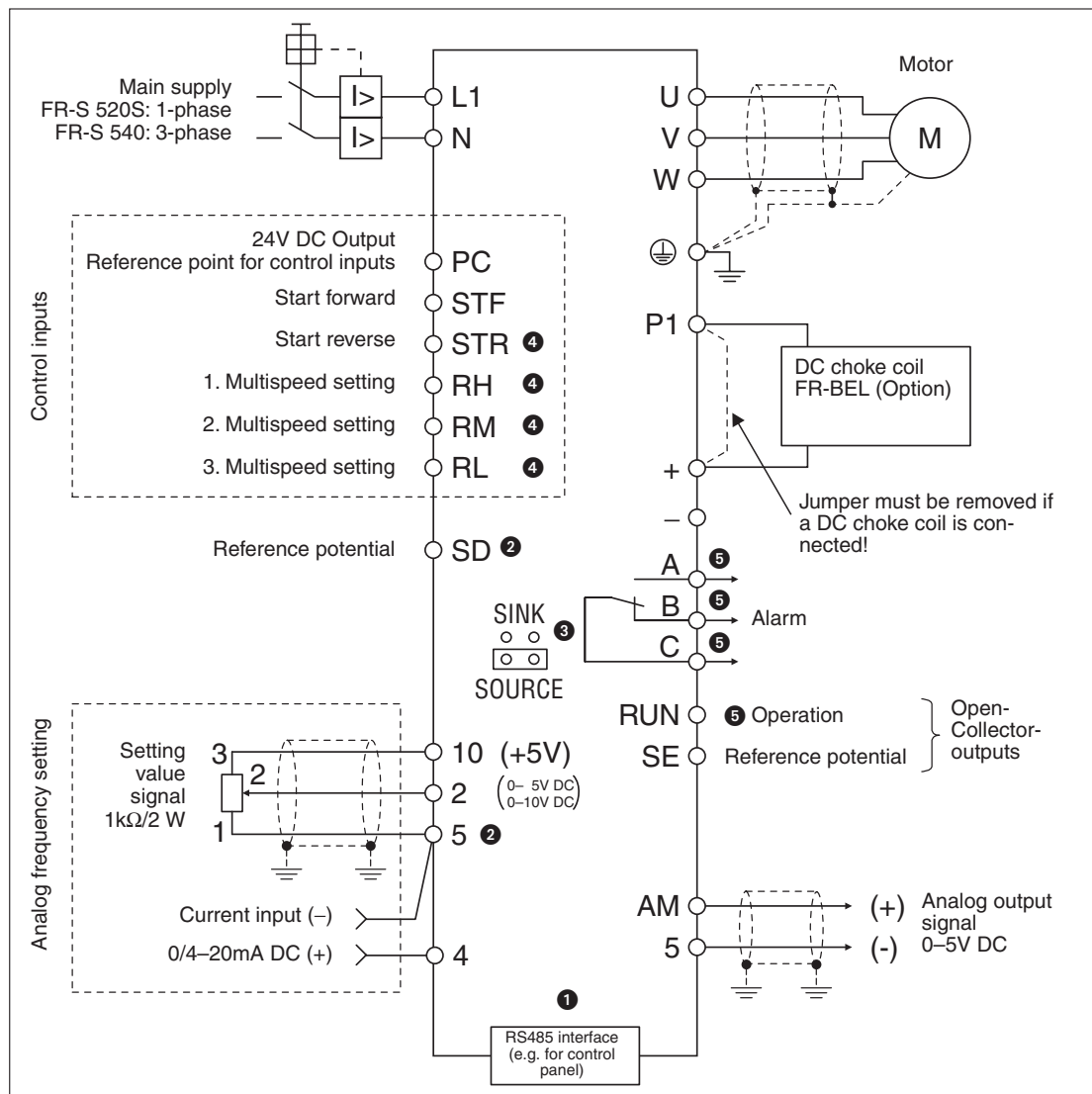
The connector above the LED display is for manufacturer use. Do not touch it as doing so may cause an electric shock.

4 Wiring

4.1 Overview


CAUTION:

The terminals PC-SD of the 24V DC power supply must not be shorted. Otherwise the inverter will be damaged.



- ① FR-S 500 ECR with RS485 interface only
- ② The terminals SD and 5 are reference potentials. They must not be grounded.
- ③ Jumper for switching between sink and source.
- ④ Possible function assignments of the input terminals by parameter 60 to 63: RL, RM, RH, RT, AU, STOP, MRS, OH, REX, JOG, RES, X14, X16 and (STR).
- ⑤ Possible function assignments of the output terminals by parameter 64 to 65: RUN, SU, OL, FU, RY, Y12, Y13, FDN, FUP, RL, LF and ABC.

4.2 Wiring of the Main Circuit



DANGER:

The frequency inverter must always be powered off completely before performing any wiring work. Before starting rewiring or other work after performing operation once, check the voltage with a meter etc. more than 10 minutes after power-off. For some time after power-off, there is a dangerous voltage in the capacitor.



CAUTION:

*Power must not be applied to the output terminals (U, V, W) of the inverter. Otherwise the inverter will be damaged.
The inverter must be grounded using the dedicated ground terminal.*

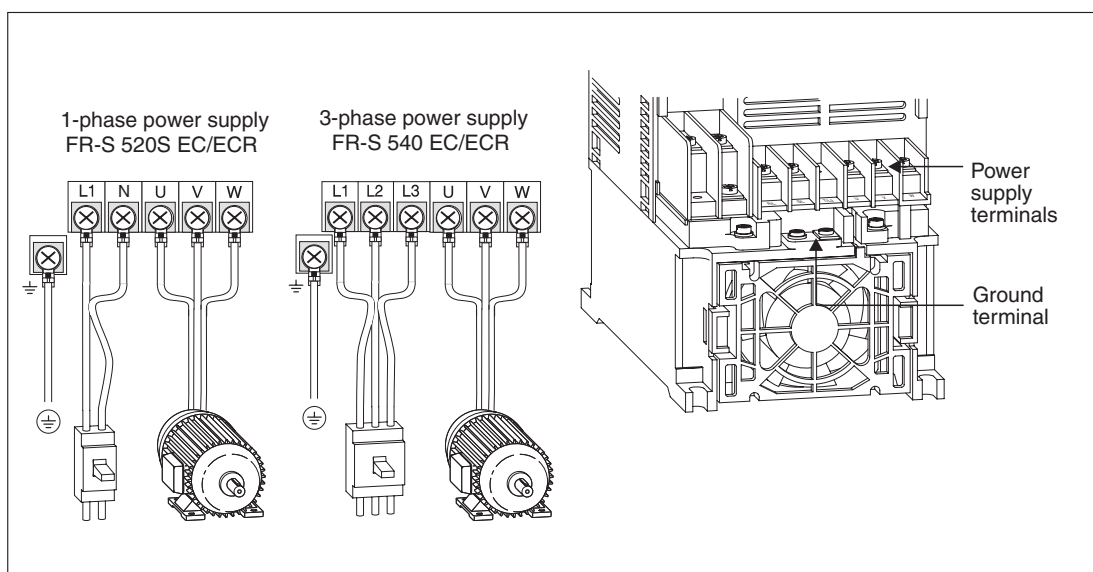
4.2.1 Mains, Motor and Ground Terminal Connections

The terminal blocks for connection of the frequency inverter can be accessed by removing the front cover and the wire cover. Connect a 1-phase power supply to the terminals L1 and N when using the inverter FR-S 520S EC/ECR and a 3-phase power supply to the terminals L1, L2 and L3 when using the inverter FR-S 540 EC/ECR. The required power supply is 200–240V AC, –15% / +10% for the inverter type FR-S 520S EC/ECR and 380–480V AC for the inverter type FR-S 540 EC/ECR. The mains frequency is 50–60Hz $\pm$ 5% for all types.

Connect the motor cables to terminals U, V and W. The illustration below shows the correct assignments for the power connections. The required cable size is 1.5mm² up to the capacity class 0.75k and 2.5mm² for higher capacity classes.

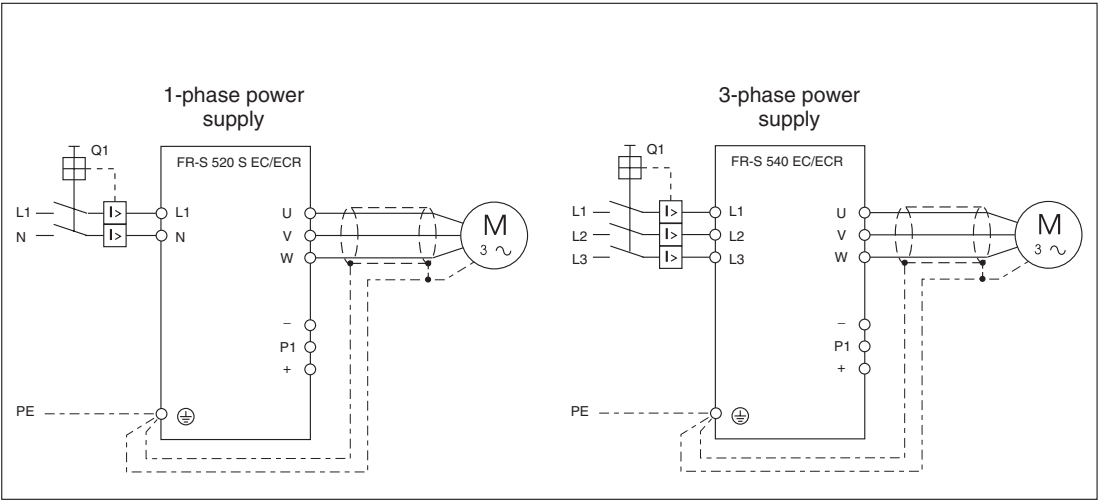
NOTE

The inverter must be grounded using the dedicated ground terminal.



NOTE

It is recommended to use a shielded motor cable in order to reduce cable radiation.



NOTE

The maximum wiring length of the motor cable is 100m. When automatic torque boost is selected in Pr. 98, the maximum wiring length is 30m.

The following table shows the terminal assignment of main circuit terminals.

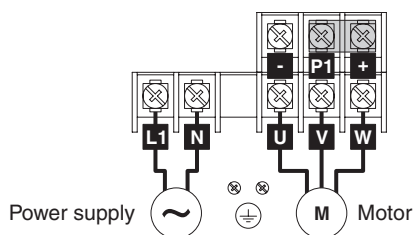
	Terminal	Terminal name	Description
Main circuit connector	L1, N L1, L2, L3	Mains supply connection	Mains power supply of the inverter
	+, -	External brake unit connection	An external brake unit can be connected to the terminals + and -.
	P1, +	DC choke coil connection	An optional choke coil can be connected to the terminals P1 and +. Disconnect the jumper before connecting the choke coil.
	U, V, W	Motor connection	Voltage output of the inverter (3-phase, 0V up to power supply voltage, 0.5–120Hz)
		PE	Protective earth connection of inverter



CAUTION:
Switching the unit off and on repeatedly with the mains power supply at short intervals can damage the switch-on current limiter. Because of this the unit should always be started and stopped with the control unit or via the STF/STR and STOP control signals.

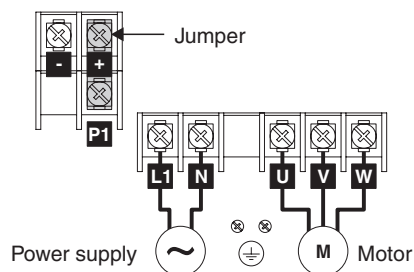
4.2.2 Main Circuit Terminals

FR-S 520S-0.2k to 0.75k EC/ECR



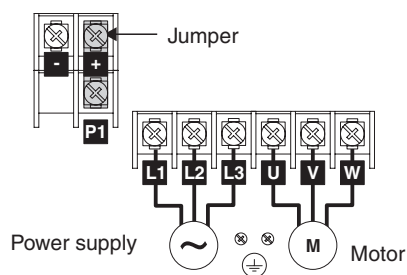
Screw size: M3.5
Screw tightening torque: 1.2Nm

FR-S 520S-1.5 k EC/ECR



Screw size: M4
Screw tightening torque: 1.5Nm

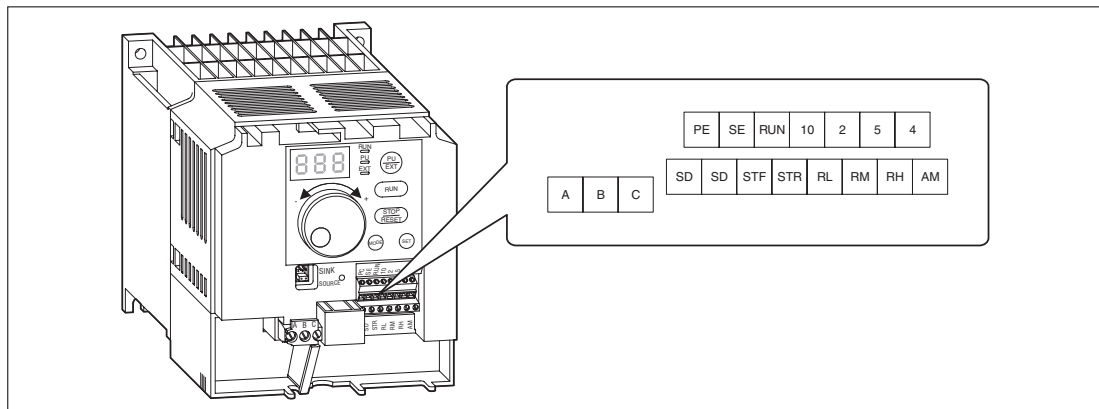
FR-S 540-0.4 k to 3.7 k EC/ECR



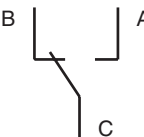
Screw size: M4
Screw tightening torque: 1.5Nm

4.3 Wiring of the Control Circuit

The following picture shows the arrangement of the terminal for the control circuit of the inverter.



Signal	Terminal	Terminal name	Description
Input signals	Contact input	STF	Forward rotation start The motor rotates forward, if a signal is applied to terminal STF. When the STF and STR signals are turned on simultaneously, the stop command is given.
		STR	Reverse rotation start The motor rotates reverse, if a signal is applied to terminal STR. When the STF and STR signals are turned on simultaneously, the stop command is given.
		RH, RM, RL	Multi-speed selection Up to 15 different output frequencies can be preset; for the speed commands the following priorities apply: Jog, speed selection (RH, RM, RL, RX) and AU.
	Common	SD ②	Common sink for contact input/reference potential A determined control function is activated, if the corresponding terminal is connected to the terminal SD. The SD terminal is isolated from the digital circuits via optocouplers. The terminal is isolated from the terminals 5 and SE.
		PC ②	24V DC output and common source for contact input/reference potential 24V DC / 0.1A output via PC-SD In sink logic, when activated by open collector transistors (e.g. PLC) the positive pole of an external power supply has to be connected to the PC terminal. In source logic, the PC terminal serves as common reference point for the control inputs.
Analog	Setting value specification	10 (output voltage 5V DC)	Output voltage 5V DC Max. output current 10mA. Recommended potentiometer: 1kΩ, 2W linear, multiturn potentiometer
		2	Input for frequency setting-value signal The voltage setting value 0–5 (10) V is applied to this terminal. The voltage range is preset to 0–5V. (Parameter 73). The input resistance is 10kΩ; The maximum permitted voltage is 20V.
		5	Reference point for frequency setting value signal Terminal 5 is the reference point for all analog setting values (Terminal 2 and 4) and for the analog output signal AM. The terminal is not isolated from the terminals SD and SE and must not be earthed .
		4	Input for current setting value signal 0/4–20mA DC The current setting value signal (0/4–20mA DC) is applied to this terminal. The input is active only if the AU signal is set. The function of the AU signal is assigned via parameters 60 to 63. The input resistance is 250Ω, the max current is 30mA. By default, this signal is set to 0Hz at 4mA and 50Hz at 20mA.

Signal	Terminal	Terminal name	Description
Output signals	Contact	A, B, C	Potential free alarm output  The maximum contact load is 230V / 0.3A AC or 30V / 0.3A DC.
		SE	Reference potential for the signal RUN. This terminal is isolated from the reference potential of the control circuit 5 and SD.
	Open Collector	RUN	The output is switched low, if the inverter output frequency is equal to the starting frequency. The output is switched high, if no frequency is output or the DC brake is in operation. The maximum contact load is 24V DC / 0.1A.
		AM	Reference potential for the signal RUN. This terminal is isolated from the reference potential of the control circuit 5 and SD. One of the following monitoring functions can be selected: external frequency output or motor current output. A DC voltmeter can be connected.
Commun.	RS485	—	Connection of control panel (RS485) ^④ Using the parameter unit connection cable the parameter unit (FR-PU04) is connectable. Communication operation can be performed through RS-485. I/O standard: RS485, Multi-Drop operation, max. 19200 Baud, Overall length max. 500m

- ① The following function assignments are supported: RL, RM, RH, RT, AU, STOP, MRS, OH, REX, JOG, RES, X14, X16, and (STR).
- ② The terminals PC and SD must not be connected to each other nor to the protective earth terminal.
In source logic, the terminal PC serves as common reference point for the control inputs.
In sink logic, the terminal SD serves as common reference point for the control inputs.
- ③ The following function assignments are supported: RUN, SU, OL, FU, RY, Y12, Y13, FDN, FUP, RL, LF, and ABC.
- ④ The RS485-connector is optional.

**CAUTION:**

Terminals 10 and 5 must not be connected to each other. Otherwise the internal voltage output for the connection of the potentiometer will be damaged.

5 Parameter

5.1 Overview and Setting Ranges

Function	Parameter	Meaning	Setting range	Default
Basic functions	0	Torque boost (manual)	0–15%	4/5/6% ^①
	1	Maximum frequency	0–120Hz	50Hz
	2	Minimum frequency	0–120Hz	0Hz
	3	Base frequency	0–120Hz	50Hz
	4	Multi-speed setting (high speed) ^③	0–120Hz	50Hz
	5	Multi-speed setting (middle speed) ^③	0–120Hz	30Hz
	6	Multi-speed setting (low speed) ^③	0–120Hz	10Hz
	7	Acceleration time	0–999s	5s
	8	Deceleration time	0–999s	5s
	9	Electronic thermal overload relay	0–50A	Rated current
	30	Extended function display selection ^③	0: No display 1: Display	0
	79	Operation mode selection	0–4 / 7 / 8	0
The extended function parameters are made valid by setting “1” in Pr. 30.				
Parameters for standard drive operation	10	DC injection brake operation frequency	0–120Hz	3Hz
	11	DC injection brake operation time	0–10s	0.5s
	12	DC injection brake voltage	0–15%	6%
	13	Starting frequency	0–60Hz	0.5Hz
	14	Load pattern selection	0: For constant-torque loads, 1: For variable-torque loads, 2: For vertical lift loads, 3: For vertical lift loads	0
	15	JOG frequency	0–120Hz	5Hz
	16	JOG acceleration / deceleration time	0–999s	0.5s
	17	RUN key rotation direction selection	0: forward rotation 1: reverse rotation	0
	19	Max. output voltage	0–500 (800) ^② V / 888 / ---	888
	20	Acceleration / deceleration reference frequency	1–120Hz	50Hz
	21	Acceleration / deceleration time increments	0–31 / 100	0
	22	Stall prevention operation level ^③	0–200%	150%
	23	Stall prevention operation at double speed	0–200% / ---	---
	24	Multi-speed setting (speed 4) ^③	0–120Hz / ---	---
	25	Multi-speed setting (speed 5) ^③	0–120Hz / ---	---
	26	Multi-speed setting (speed 6) ^③	0–120Hz / ---	---
	27	Multi-speed setting (speed 7) ^③	0–120Hz / ---	---
	28	Multi-speed input compensation	0–120Hz	50Hz
	29	Acceleration / deceleration pattern	0: Linear acceleration/ deceleration, 1: S-pattern acceleration/ deceleration A, 2: S-pattern acceleration/ deceleration B	0
	31	Frequency jump 1A	0–120Hz / ---	---
	32	Frequency jump 1B	0–120Hz / ---	---
	33	Frequency jump 2A	0–120Hz / ---	---
	34	Frequency jump 2B	0–120Hz / ---	---

Function	Parameter	Meaning	Setting range	Default
Standard operation functions	35	Frequency jump 3A	0–120Hz / ---	---
	36	Frequency jump 3B	0–120Hz / ---	---
	37	Speed display	0 / 0.1–999	0
	38	Frequency at 5V (10V) input voltage	1–120Hz	50Hz
	39	Frequency at 20mA input current	1–120Hz	50Hz
	40	Start-time ground fault detection selection	0: Not detected 1: Detected	1
Output terminal functions	41	Setting value / current value comparison (SU output)	0–100%	10%
	42	Output frequency monitoring (FU output)	0–120Hz	6Hz
	43	Output frequency detection for reverse rotation	0–120Hz / ---	---
Second functions	44	Second acceleration/deceleration time	0–999s	5 s
	45	Second deceleration time	0–999s / ---	---
	46	2. Manual torque boost	0–15% / ---	---
	47	Second V/F (base frequency)	0–120Hz / ---	---
Current detection	48	Output current detection level	0–200%	150%
	49	Output current detection signal delay time	0–10s	0s
	50	Zero current detection level	0–200%	5%
	51	Zero current detection time	0.05–1s	0.5s
Display functions	52	Control panel display data selection ^③	0: Output frequency, 1: Output current, 100: Set frequency during stop/output frequency during operation	0
	53	Digital Dial function selection ^③	0: Setting dial frequency setting 1: Setting dial: potentiometer mode	0
	54	Output AM terminal ^③	0: Output frequency monitor 1: Output current monitor	0
	55	Frequency monitoring reference ^③	0–120Hz	50Hz
	56	External current monitoring reference ^③	0–50A	Rated current
Automatic restart functions	57	Restart coasting time after power failure	0–5s / ---	---
	58	Restart cushion time before automatic synchronisation	0–60s	1s
Additional function	59	Selection of digital motor potentiometer	0: Without remote setting function 1: With remote setting function With frequency setting storage function 2: With remote setting function Without frequency setting storage function	0

Function	Parameter	Meaning	Setting range	Default
Terminal function selection	60	RL terminal function selection	0: RL (low speed) 1: RM (middle speed) 2: RH (high speed) 3: RT (second function selection)	0
	61	RM terminal function selection	4: AU (current input selection) 5: STOP (start self-holding selection) 6: MRS (output shut-off stop)	1
	62	RH terminal function selection	7: OH (external thermal relay input) 8: REX (15-speed selection) 9: JOG (jog operation selection)	2
	63	STR terminal function selection	10: RES (RESET) 14: X14 (PID control presence/absence selection) 16: X16 (PU-external operation switch-over) ---: -: STR (May be assigned to the STR terminal only)	---
	64	RUN terminal function selection	0: RUN (RUN terminal function selection) 1: SU (up to frequency) 3: OL (overload alarm) 4: FU (output frequency detection) 11: RY (inverter operation ready) 12: Y12 (output current detection)	0
	65	ABC terminal function selection	13: Y13 (zero current detection) 14: FDN (PID lower limit) 15: FUP (PID upper limit) 16: RL (PID forward-reverse rotation output) 98: LF (minor fault output) 99: ABC (Alarm output)	99
Operation selection functions	66	Retry selection	0: OC1 to 3, OV1 to 3, THM, THT, GF, OHT, OLT, PE, OPT 1: OC1 to 3, 2: OV1 to 3, 3: OC1 to 3, OV1 to 3	0
	67	Number of restart retries	0: No retry 1–10: Without alarm output during retry operation 101–110: With alarm output during retry operation	0
	68	Waiting time for automatic restart retry	0.1–360s	1s
	69	Retry count display erase	0: Cumulative count erase	0
	70	Soft-PWM setting ^③	0: Soft-PWM invalid, 1: Soft-PWM valid	1
	71	Motor selection	0: Thermal characteristic matching a standard motor 1: Thermal characteristic matching a Mitsubishi constant-torque motor	0

Function	Parameter	Meaning	Setting range	Default
Operation selection functions	72	PWM frequency selection ^③	0–15 0: 0.7kHz 15: 14.5kHz	1
	73	Specification of setting value input data	0: 0–5V DC 1: 0–10V DC	0
	74	Setting value signal filter	0–8	1
	75	Reset selection/PU stop ^③	0: Reset normally enabled/PU stop key disabled 1: Enabled at alarm occurrence only/PU stop key disabled 14: Reset normally enabled/normally decelerated to stop 15: Enabled at alarm occurrence only/normally decelerated to stop	14
	76	Cooling fan operation selection	0: Operation started at power-on 1: Cooling fan ON/OFF control	1
	77	Parameter write disable selection ^③	0: Write is enabled only during a stop 1: Write disabled (except some parameters) 2: Write during operation enabled	0
	78	Reverse rotation prevention selection	0: Both forward rotation and reverse rotation enabled, 1: Reverse rotation disabled, 2: Forward rotation disabled	0
Multispeed preset	80	8. Multispeed preset ^③	0–120Hz / ---	---
	81	9. Multispeed preset ^③	0–120Hz / ---	---
	82	10. Multispeed preset ^③	0–120Hz / ---	---
	83	11. Multispeed preset ^③	0–120Hz / ---	---
	84	12. Multispeed preset ^③	0–120Hz / ---	---
	85	13. Multispeed preset ^③	0–120Hz / ---	---
	86	14. Multispeed preset ^③	0–120Hz / ---	---
	87	15. Multispeed preset ^③	0–120Hz / ---	---
PID control	88	PID action selection	20: PID reverse action, 21: PID forward action	20
	89	PID proportional band ^③	0.1–999% / ---	100%
	90	PID integral time ^③	0.1–999s / ---	1s
	91	PID upper limit	0–100% / ---	---
	92	PID lower limit	0–100% / ---	---
	93	PID action set point for PU operation ^③	0–100%	0%
	94	PID differential time ^③	0.01–10s / ---	---
Slip compensation	95	Rated motor slip	0–50% / ---	---
	96	Slip compensation time constant	0.01–10s	0.5s
	97	Output region for slip compensation	0 / ---	---
Autom. torque boost	98	Automatic torque boost (motor capacity)	0.1–3.7kW ^⑥ / ---	---
	99	Motor primary resistance constant A	0–50Ω / ---	---

Function	Parameter	Meaning	Setting range	Default
Calibration functions	C1 (901) ⑤	AM terminal calibration	Calibration range	—
	C2 (902) ⑤	Frequency setting voltage bias frequency	0–60Hz	0Hz
	C3 (902) ⑤	Frequency setting voltage bias	0–300%	0% ④
	C4 (903) ⑤	Frequency setting voltage gain	0–300%	96% ④
	C5 (904) ⑤	Frequency setting current bias frequency	0–60Hz	0Hz
	C6 (904) ⑤	Frequency setting current bias	0–300%	20% ④
	C7 (905) ⑤	Frequency setting current gain	0–300%	100% ④
	C8 (269) ⑤	Parameter set by manufacturer: Do not set!		
Clear functions	CLr	Clear parameter	0: Do not clear parameter 1: Clear parameter 10: Clear all parameters	0
	ECL	Clear alarm history ③	0: Do not clear alarm history 1: Clear alarm history	0
Parameters only for the type having the RS-485 communication function (When the parameter unit (FR-PU04) is used, operation from the operation panel is not accepted.)				
Communi- cation functions	n1 (331) ⑤	Station number	0–31	0
	n2 (332) ⑤	Communication speed	48: 4800 Baud 96: 9600 Baud 192: 19200 Baud	192
	n3 (333) ⑤	Stop bit length / data length	0 / 1: Data length 8 10 / 11: Data length 7	1
	n4 (334) ⑤	Parity check	0: Absent 1: With odd parity check 2: With even parity check	2
	n5 (335) ⑤	Number of communication retries	0–10 / ---	1
	n6 (336) ⑤	Communication check time interval	0–999s / ---	---
	n7 (337) ⑤	Wait time setting	0–150ms / ---	---
	n8 (338) ⑤	Operation command write	0: Command write from computer 1: Command write from external terminal	0
	n9 (339) ⑤	Speed command write	0: Command write from computer 1: Command write from external terminal	0
	n10 (340) ⑤	Link start mode selection	0: As set in Pr. 79 1: Started in computer link operation mode.	0

Function	Parameter	Meaning	Setting range	Default
Communi- cation Param- eters	n11 (341) ⑤	CR / LF selection	0: Without CR/LF 1: With CR, without LF 2: With CR/LF	1
	n12 (342) ⑤	E ² PROM selection	0: Write to RAM and E ² PROM 1: Write to RAM only	0
	n13 (145) ⑤	PU display language	0: Japanese 1: English 2: German 3: French 4: Spanish 5: Italian 6: Swedish 7: Finish	1
	n14 (990) ⑤	PU buzzer sound control ③	0: Without sound 1: With sound	1
	n15 (991) ⑤	PU contrast adjustment ③	0 (bright) to 63 (dark)	58
	n16 (992) ⑤	PU main display screen data selection ③	0: Selectable between output frequency and output current 100: (during stop): Set frequency, output current (during operation): Output frequency, output current	0
	n17 (993) ⑤	PU disconnection detection / PU setting lock	0: Without PU disconnection error 1: Error at PU disconnection 10: Without PU disconnection error (PU operation disable)	0

Remarks:

- ① FR-S 520S EC/ECR and FR-S 540-0.4 to 0.75k = 6%, FR-S 540-1.5 to 2.2k = 5%,
FR-S 540-3.7k = 4%
- ② Setting range FR-S 520S EC/ECR = 0–500V, FR-S 540 EC/ECR = 0–800V;
Value 888 = 95% of the power supply voltage
- ③ The settings of the parameters can be changed during operation, provided parameter 77 is
set to “0”. Parameters 53, 70, and 72 can only be changed during PU operation.
- ④ The values depend on the settings of the calibration parameters.
- ⑤ The parameter numbers in brackets are displayed by the parameter unit FR-PU04.
- ⑥ Setting range FR-S 520S EC/ECR = 0.1–3.7kW, FR-S 540 EC/ECR = 0.2–3.7kW

6 Protective Functions

6.1 Error Messages and Remedies

Error message		Meaning	Description	Remedy
Display FR-PU04	LED- display			
OC During Acc	OC 1	Overcurrent1 (acceleration)	A) The output current of the inverter has reached or exceeded 200% of the rated current during acceleration, deceleration, or at constant speed. B) The temperature of the main circuits of the inverter rises rapidly.	The cause for the activation of the protective function is a short circuit or a ground fault across the main outputs, an exceeding moment of inertia Overcurrent 2 of the load (GD^2), too short acceleration/ deceleration time presets, restart during a motor idling phase, operation of a motor with an exceeding capacity. Overheating due to insufficient cooling (defective cooling fan or choked heat sink).
Steady Spd OC	OC 2	Overcurrent12 (const. speed.)		
OC During Dec	OC 3	Overcurrent13 (deceleration)		
OV During Acc	OV 1	Overvoltage 1 (acceleration)	The converter voltage has increased highly due to regenerative energy. The overvoltage limit was exceeded during acceleration, deceleration, or at constant speed.	In most cases the protective function is activated due to a too short deceleration time preset or a regenerative overload. Increase the deceleration time by connecting an external brake unit. An overvoltage in the mains power supply activates this protective function as well.
Steady Spd OV	OV 2	Overvoltage 2 (const. Speed)		
OV During Dec	OV 3	Overvoltage 3 (deceleration)		
Motor Overload	FOH	Overload (Motor)	The electronic overload protection for the motor or inverter was activated. If a self-cooling motor operates over a long period at low speed but high torque, the motor is thermally overloaded and the protective function is activated.	Decrease the motor load to avoid an activation. Check whether the performance range of the motor and inverter correspond.
Inv. Overload	FOI	Overload (Inverter)		
H/Sink O/Temp	FI n	Fin overheat	If the cooling fin overheats, the fin overheat sensor activates and halts inverter output.	Check ambient temperature.
F _n	F_n	Fan breakdown	The cooling fan breaks down or an operation different from the setting of Pr. 76 is performed.	Replace cooling fan.
Ground fault	GF	Ground fault	An overcurrent occurred due to a ground fault upon the inverter output (load side). Made valid when Pr. 40 "start-time ground fault detection selection" = "1".	Check load connections (motor circuit).
OH Fault	OHI	Activation of an external motor protection relay (thermal contact)	An external motor protective switch was activated. If an external motor protective switch for thermal monitoring is used, this switch can activate the protective function of the inverter.	Check motor load and drive.
Still Prev STP	OLP	Stall prevention overload	A long lasting excess of the current limit (OL display) shuts down the inverter.	Reduce the load. Check the preset values for the current limit (Pr. 22) and the stall prevention selection (Pr. 21).
Option Fault	OPF	Communication error	The protective function is activated, if a setting or connection error occurs during serial communication	Check connections and connectors of the operating unit
Corrupt Memory	PE	Memory error	Error on access of the data memory of the inverter.	Please contact your nearest MITSUBISHI ELECTRIC representative if the error occurs again.

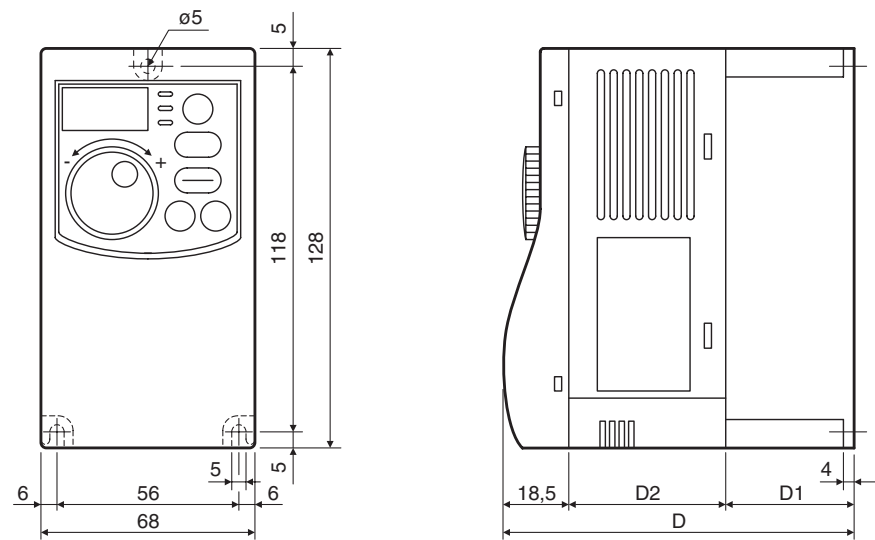
Error message		Meaning	Description	Remedy
Display FR-PU04	LED- display			
PU Leave Out	<i>PUE</i>	Parameter unit connection error	A connection error between in- verter and external parameter unit occurred during operation. This alarm is only returned, if Pr. 17 is set to "1".	Check the connection of the pa- rameter unit.
Retry No Over	<i>rEr</i>	Automatic re- start retry ex- ceeded	After activation of a protective function the inverter failed to be restarted automatically within the number of retries specified in Pr. 67.	Remedy the actual cause of the originary protective function.
CPU Fault	<i>CPU</i>	CPU error	Failure on CPU printed circuit board.	Contact the MITSUBISHI ELEC- TRIC customer service
PS	<i>PS</i>	Inverter was stopped via con- trol panel or PU	STOP key on the control panel or PU was pressed during exter- nal operating mode.	Check Pr. 75.
OL	<i>OL</i>	Overcurrent during acceleration	If a current of more than 150 % ^① of the rated inverter current flows in the motor, this function stops the increase of the fre- quency until the overload cur- rent reduces to prevent the in- verter from resulting in overcurrent shut-off.	Change the acceleration/deceler- ation time. Increase the stall pre- vention operation level via Pr. 22. Disable the stall prevention via Pr. 21. Check whether the torque boost in Pr. 0 is set higher than re- quired.
		Overcurrent during constant speed	If a current of more than 150 % ^① of the rated inverter current flows in the motor, this function lowers the frequency until the overload current reduces to pre- vent the inverter from resulting in overcurrent shut-off.	
		Overcurrent during decelera- tion	If a current of more than 150 % of the rated inverter current flows in the motor, this function stops the decrease of the fre- quency until the overload cur- rent reduces to prevent the in- verter from resulting in overcurrent shut-off.	
oL	<i>oL</i>	Overvoltage during deceleration	If the regenerative energy of the motor exceeds the brake capac- ity of the inverter, this function stops the decrease of the fre- quency to prevent overvoltage shut-off. When the regenerative energy has reduced, decelera- tion resumes.	Increase the deceleration time using Pr. 8 "deceleration time".
	<i>Uu</i>	Undervoltage	The power supply voltage is too low.	Check the power supply voltage.
Control Mode	<i>Er 1</i>	Write error	Write was performed with "1" (write disable) set in Pr. 77 or frequency jump setting range overlapped or parameter write was performed via the control panel although it was not write enabled.	Check the settings of Pr. 77, 31 to 36, and n17.
In PU/EXT Mode OPERATOR ERR	<i>Er 2</i>	Write error	Write was performed during op- eration or in the external op- eration mode or an attempt was made to change the operation mode set by an operation com- mand via Pr. 79.	Stop operation before changing settings. Select PU (parameter unit) op- eration mode.
Incr I/P	<i>Er 3</i>	Calibration error	Analog input bias and gain are set too closely.	Check the settings of Pr. C3, C4, C6, and C7.

① The current limit value (Pr. 22) can be changed. By default, it is set to 150%.

7 Dimensions

7.1 Frequency Inverters

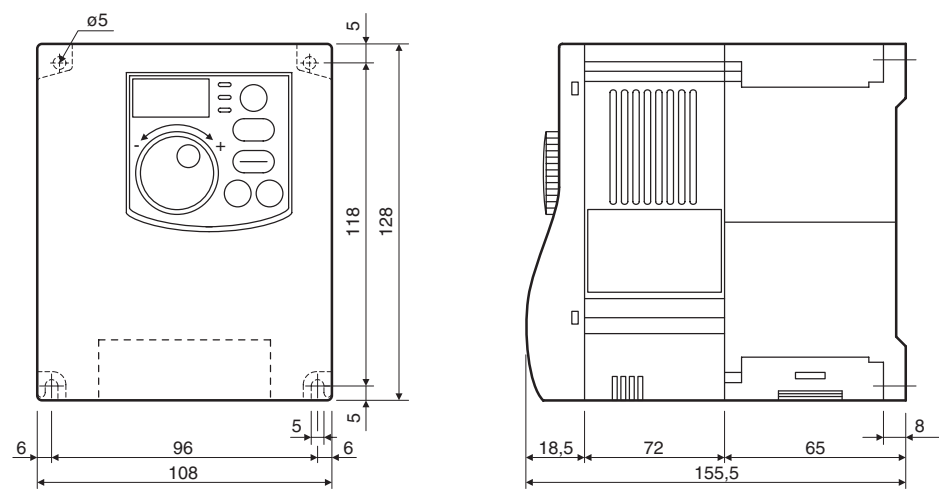
FR-S 520S-0.2k to 0.75k EC/ECR



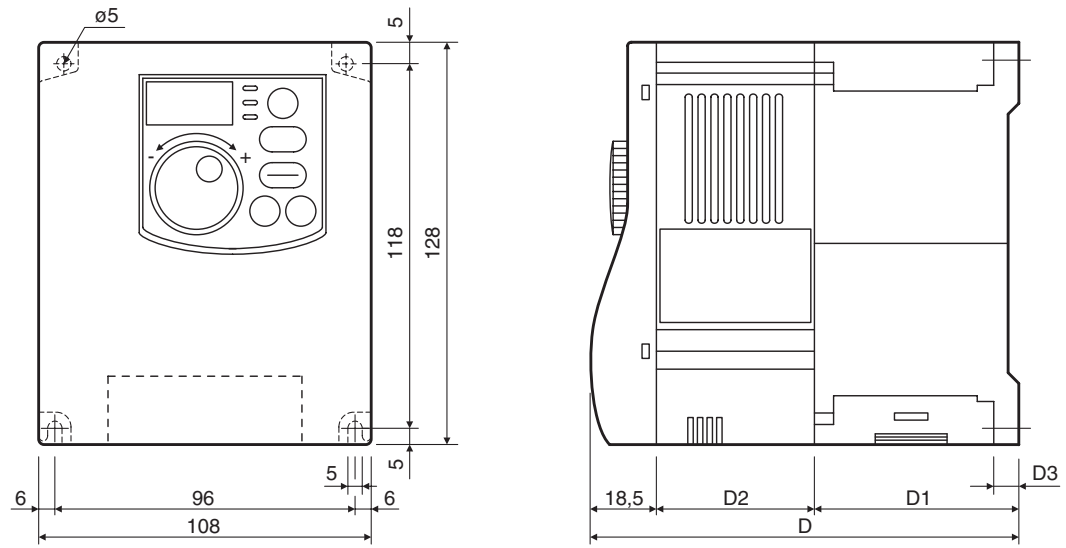
Type	D	D1	D2
FR-S 520S-0.2k EC/ECR	80.5	10	52
FR-S 520S-0.4k EC/ECR	142.5	42	82
FR-S 520S-0.75k EC/ECR	162.5	62	82

Unit: mm

FR-S 520S-1.5k EC/ECR



Unit: mm

FR-S 540-0.4k to 3.7k EC/ECR


Unit: mm

Type	D	D1	D2	D3
FR-S 540-0.4k EC/ECR	129.5	59	52	5
FR-S 540-0.75k EC/ECR	129.5	59	52	5
FR-S 540-1.5k EC/ECR	135.5	65	52	8
FR-S 540-2.2k EC/ECR	155.5	65	72	8
FR-S 540-3.7k EC/ECR	165.5	65	82	8

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